DEFENSE ACQUISTION UNIVERSITY
BUSINESS, COST ESTIMATING, & FINANCIAL MANAGEMENT DEPARTMENT

OCT 02

TEACHING NOTE

INTRODUCTION TO COST ANALYSIS

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BACKGROUND

All Department of Defense (DoD) Military Departments and Defense Agencies (herein referred to as "DoD Components") prepare ***life-cycle cost estimates (LCCEs)*** in support of their acquisition programs. A LCCE attempts to identify all the costs of an acquisition program, from its initiation through disposal of the resulting system at the end of its useful life.

LCCEs for DoD systems serve two primary purposes. First, they are used at acquisition program milestone and decision reviews to assess whether the system's cost is ***affordable***, or consistent with the DoD Component's and DoD's overall long-range investment and force structure plans. Second, LCCEs form the basis for budget requests to Congress.

As in other aspects of acquisition management, maximum use should be made of the Integrated Product and Process Development (IPPD) concept and Integrated Product Teams (IPTs) in the development and review of LCCEs.

THE LIFE-CYCLE MANAGEMENT MODEL

New acquisition programs arise from the existence of either warfighting deficiencies or opportunities to provide new capabilities as documented in Mission Needs Statements (MNS). The MNS describes the broadly defined operational capability required to satisfy a deficiency and documents reasons why non-materiel changes (e.g., tactics or doctrine) cannot meet this need, thereby requiring a materiel solution (i.e., an acquisition program). These broad capabilities are then refined into system operational requirements consistent with the type of system proposed to remedy the mission need.

Based on all known requirements, the program office prepares an initial LCCE for its acquisition program. As the program passes through its various phases and milestone decision points, the LCCE is updated by the program office and reviewed by decision-makers. In the cases of major weapon system and major automated information system (AIS) acquisitions, at least one additional LCCE must be prepared by an organization independent of the program office and the acquisition chain of command (see "Cost Estimating/Analysis Review Process" section later in this note.)

For weapon system acquisition programs, the LCCE helps decision-makers assess the affordability of the system. For AIS acquisition programs, the LCCE provides input for the required ***cost-benefit analysis***. The cost-benefit analysis enables decision-makers to assess whether the AIS will produce satisfactory returns for its investment.

LCCEs are prepared in terms of ***base-year dollars*** (also known as ***constant dollars***) for a selected base year (usually the year of program initiation or last major milestone review), i.e., inflation is not considered for the multiple years over which funds will be required for the acquisition program. Thereafter, those base-year dollar cost estimates (escalated to ***then-year dollars*** for inflation and outlay patterns) are used as the basis for input to the programming and budgeting phases of the Planning, Programming and Budgeting System (PPBS). These estimates ultimately form the basis for the acquisition program's funding request contained in the President's Budget submitted to Congress.

THE LIFE-CYCLE COST MODEL

Life-cycle cost (LCC) can be defined as the total cost to the government of a program over its full life, including costs for research and development; testing; production; facilities; operations; maintenance; personnel; environmental compliance; and disposal. Each of the program's major stakeholders (Congress, program office, contractors, and DoD decision-makers) prefer to view life cycle costs grouped in a way that reflects its particular perspective. The three major ways of grouping and viewing program LCC are:

(1) ***By funding appropriation:*** DoD receives appropriations from Congress falling into these five major categories: Research, Development, Test and Evaluation (RDT&E); Procurement; Operations and Maintenance (O&M); Military Construction (MILCON); and Military Personnel (MILPERS). Program life-cycle costs are broken out along these lines to develop internal budgets and submit budget requests to Congress.

(2) ***By Work Breakdown Structure (WBS):*** A program WBS provides a framework for program and technical planning, cost estimating, resource allocations, performance measurements, and status reporting. The WBS should define the total system to be developed or produced; display the total system as a product-oriented family tree composed of hardware, software, services, data, and facilities; and relate the elements of work to each other and to the end product. Major acquisition programs shall tailor a program WBS in accordance with the guidance in MIL-HDBK-881B. Since MIL-HDBK-881B does not address AIS programs, managers of these programs should develop their own program-specific WBS in consultation with appropriate IPT members. Cost breakouts by WBS elements are useful to the program office and contractors in managing the program.

(3) ***By life-cycle cost categories:*** DoD 5000.4-M, Cost Analysis Guidance and Procedures, defines these cost categories:

- ***Research & Development (R&D)***: Cost of all research and development, from program initiation through the Full Rate Production decision (end of engineering and manufacturing development for grandfathered programs)[1].

- ***Investment***: Cost of the investment phase, including total cost of procuring the prime equipment; related support equipment; training; initial and war reserve spares; pre-planned product improvements and military construction.

- ***Operating and Support (O&S)***: Cost of operating and supporting the fielded system, including all direct and indirect costs incurred in using the system, e.g., personnel, maintenance (unit and depot), and sustaining investment (replenishment spares). The bulk of life-cycle costs occur in this category.

- ***Disposal***: Cost to dispose of the system after its useful life. This includes demilitarization, detoxification, long-term waste storage, environmental restoration and related costs.

DoD decision-makers and program managers use cost categories to establish life-cycle cost objectives associated with the concept of Cost as an Independent Variable (CAIV). *(Note: The Investment category for CAIV management purposes can be split into two parts: Procurement and Military Construction).*

Table 1 shows some typical distributions of costs for major system types based on cost estimates prepared by the military components' cost analysis agencies.

System Type	R&D	Investment	O&S/Disposal
Space	18%	66%	16%
Fixed Wing Aircraft	20%	39%	41%
Rotary Wing Aircraft	15%	52%	33%
Missiles	27%	33%	39%
Electronics	22%	43%	35%
Ships **(note 1)**	1%	31%	68%
Surface Vehicles	9%	37%	54%
AIS **(note 2)**		30%	70%

Source: Status of DoD's Capability to Estimate the Cost of Weapon Systems: 1999 Update

Table 1

Notes: (1) Most ship design costs are included in production cost of lead ship of a class
(2) Available data precludes split of pre-O&S costs into R&D and Investment categories

[1] This teaching note refers to the defense acquisition process defined in the 2002 versions of DoD Directive 5000.1, DoD Instruction 5000.2-I, and DoD 5000.2-R. "Grandfathered" programs are those programs that continue to operate under the process described in the 1996 versions of DoDD 5000.1 and DoD 5000.2-R. Not incorporated are expected changes to DoD Directive 5000.1 and DoD Instruction 5000.2 currently in draft form. It is expected that DoD 5000.2-R will be cancelled and probably rewritten as a guidance manual.

Life Cycle Cost Composition

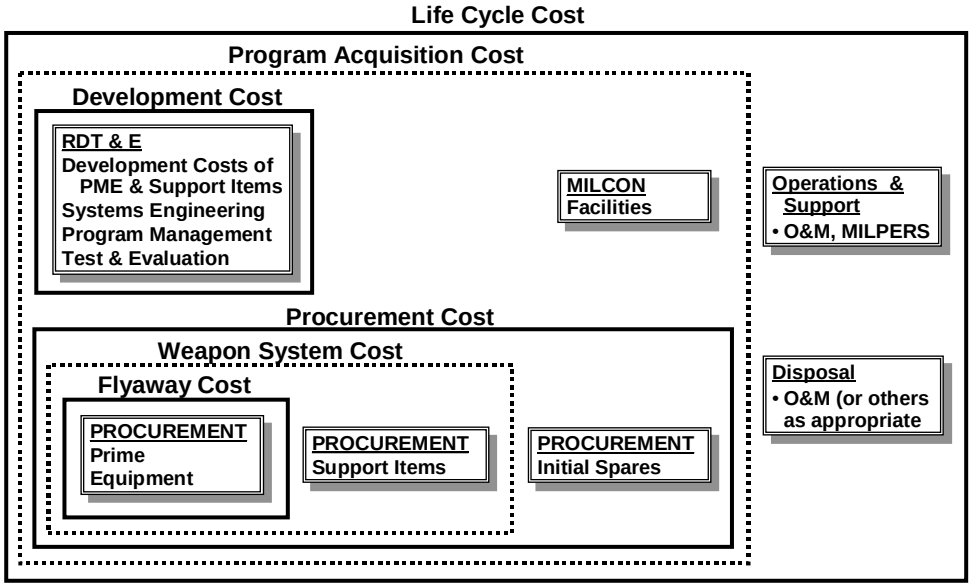

Figure 1

Common Cost Terms

DoD uses a number of different cost terms in various PPBS documents, such as the Program Objectives Memoranda (POM), Budget Estimate Submissions (BES), etc.; in acquisition program reports such as the Defense Acquisition Executive Summary (DAES) and the Selected Acquisition Report (SAR); and in various congressional information sheets. The seven cost terms shown in **Figure 1** have been standardized to ensure consistency in the defense acquisition process. DoD 5000.4-M specifically defines what is included or excluded from each term and identifies relationships to WBS elements, funding appropriations and cost categories. Note that a WBS element can be funded by multiple appropriations.

In Figure 1, the appropriation(s) which may be covered by a particular cost term are shown in bold and underlined at the top of the cost term box. The items shown below the appropriation(s) are some of the specific WBS elements that are included in that cost term.

- ***Development Cost*** is the cost of all research and development-related activities, contract and in-house, necessary to design and test the system. It includes a number of WBS elements, including Prime Mission Equipment, Support Equipment, Training, etc. Prototypes and test articles are included in this cost category. Development costs are funded with only the RDT&E appropriation and are included only in the R&D cost category.

- ***Flyaway Cost*** *(Rollaway, Sailaway, etc.)* refers to the cost of procuring prime mission equipment (e.g., an aircraft, ship, tank, etc.). It is funded with Procurement appropriations and is

part of the Investment cost category. Figure 1 shows that this term includes the WBS elements of Prime Mission Equipment, System Engineering/Program Management, System Test and Evaluation, Warranties, and Engineering Changes. (*Note: DoD 5000.4-M defines flyaway cost as being funded out of the RDT&E and Procurement appropriations, but in practice, only the Procurement-funded portion of flyaway is considered relevant by decision-makers in DoD and in Congress*.)

- ***Weapon System Cost*** is funded completely from the Procurement appropriations. It is the procurement counterpart of Development Cost in that it contains the same WBS elements as Development Cost. Weapon System Cost consists of the Flyaway Cost plus the additional WBS elements shown in Figure 1.

- ***Procurement Cost*** is also funded completely from the Procurement appropriations. It includes Weapon System Cost plus the WBS element of initial spares. For Navy shipbuilding programs, outfitting and post-delivery costs are also included when these costs are Procurement-funded.

- ***Program Acquisition Cost*** is a multi-appropriation cost. It consists of all costs associated with developing, procuring and housing a weapon system. Because it consolidates development, procurement and military construction costs, RDT&E, Procurement and MILCON appropriations are included. This is the complete cost of acquiring a weapon system - ready to operate.

- ***Operating and Support Costs*** are funded primarily with the O&M and Military Personnel appropriations. However, RDT&E, Procurement, and/or MILCON appropriations may also be used, as appropriate, based on the nature of the effort, after the weapon system has been deployed. This category includes all costs for personnel, equipment, and supplies associated with operating, modifying, maintaining and supporting a weapon system in the DoD inventory. This includes all direct and indirect costs. These costs do not include any of the development costs, procurement costs or any other part of the program acquisition costs for the weapon system, nor do they include any disposal costs for the weapon system. Because the system is already fielded, the MIL-HDBK 881B WBS does not apply to this cost term.

- ***Life-Cycle Cost*** includes <u>all</u> WBS elements, a<u>ll</u> appropriations, and <u>all</u> cost categories. As shown in Figure 1, it is the sum of Program Acquisition Cost, Operating and Support Cost, and Disposal Cost for a system.

<u>Time Phasing of Costs</u>

In addition to looking at program costs aggregated in the various ways discussed above (i.e., appropriations, WBS and life cycle cost categories), we must also be able to determine <u>when</u> these costs will be incurred. Obviously, all costs of a program are not incurred during one fiscal year and, because DoD requests and receives funding annually from Congress, we need to allocate the costs to the fiscal years when funds will be required. The time phasing of funding requirements is particularly important in the PPBS process. This topic is addressed in a separate teaching note entitled "Building the Program Budget."

TOTAL OWNERSHIP COST

In light of shrinking defense budgets, DoD is focusing on reducing the overall cost of the DoD establishment and its major subdivisions (i.e., the DoD Components), with the goal of freeing up funding for modernization and recapitalization of weapon systems. In a November 1998 memo, the Undersecretary of Defense for Acquisition, Technology & Logistics (USD(AT&L)) defined the concept of ***Total Ownership Cost (TOC)*** in its broadest context at the DoD level and at its most narrow context at the systems level. As stated in the memo:

- ***DoD TOC*** is the sum of all financial resources necessary to organize, equip, train, sustain and operate military forces sufficient to meet national goals in compliance with all laws, all policies applicable to DoD, all standards in effect for readiness, safety, and quality of life, and all other official measures of performance for DoD and its Components. DoD TOC is comprised of costs to research, develop, acquire, own, operate and dispose of weapon and support systems, other equipment and real property, the costs to recruit, train, retain, separate and otherwise support military and civilian personnel, and all other costs of business operations of the DoD.

- ***Defense Systems TOC*** (consistent with the DoD 5000.4-M) is defined as Life Cycle Cost (LCC). LCC includes not only acquisition program direct costs, but also the indirect costs attributable to the acquisition program (i.e., costs that would not occur if the program did not exist). For example, indirect costs would include the infrastructure that plans, manages, and executes a program over its full life and common support items and systems.

Acquisition program managers are responsible for supporting the reduction of DoD TOC through the continuous reduction of LCC for their systems. DoD TOC reduction efforts are being implemented by all DoD Components.

COST ANALYSIS REQUIREMENTS DESCRIPTION (CARD)

Analysts need extensive information about an acquisition program in order to estimate its cost to the detail required by the various display formats identified in the life-cycle cost model. This information is provided in the document known as the ***Cost Analysis Requirements Description (CARD)***. The CARD is a complete description of the system whose costs are to be estimated; it is intended to define the program to a sufficient level of detail such that no confusion exists between the many parties who may be concerned with estimating the program's cost. DoD 5000.4-M provides guidance regarding CARD preparation.

Per DoD 5000 series, a CARD will be prepared for all ACAT I and ACAT IA programs. The DoD component sponsoring the acquisition program is responsible for preparation of the CARD, in coordination with appropriate IPT members. Per DoD 5000.4-M, the CARD should be considered a "living document" that is updated in preparation for all milestone and program

reviews, if not annually. The updates reflect any changes that have occurred, or new data that have become available, since the previous milestone or program review. DoD Instruction 5000.2 requires ACAT I and IA programs to update the CARD at Milestone B, Milestone C, and the Full Rate Production Decision Review. A draft version of the CARD is required 180 days prior to the milestone or decision review and the final version is required 45 days prior to the milestone or decision review.

COST ESTIMATING/ANALYSIS REVIEW PROCESS

Legal and Regulatory Requirements

- **Title 10, United States Code**, **Section 2434,** requires that the Secretary of Defense consider an independent estimate of the life-cycle cost of a Major Defense Acquisition Program (MDAP) cost prior to granting Milestone B (Milestone II for grandfathered programs) and Milestone C (Low Rate Initial Production) approval. This LCCE is known as the ***"Independent Cost Estimate" (ICE)***. This independent estimate must be produced by an entity outside the development and acquisition chain(s) of command.

- **Title 44, United States Code, Section 3506 and the Clinger-Cohen Act of 1996, Section 5122** require that cost-benefit analysis be performed for all Major Automated Information System (MAIS) acquisitions.

- **DoD Instruction 5000.2 and DoD Regulation 5000.2-R** implement the legal requirements above and mandate additional cost estimating requirements for ACAT I (MDAP) and ACAT IA (MAIS) programs. Requirements for the preparation and review of LCCEs for these programs are summarized below:

  - The ***OSD Cost Analysis Improvement Group (CAIG)*** performs the ICE for all **ACAT ID** programs and for **certain ACAT IC** programs as requested by the USD(AT&L). This CAIG ICE is prepared for Milestone B (Milestone I for grandfathered programs), Milestone C (Milestone II for grandfathered programs) and the Full Rate Production Decision Review (Milestone III for grandfathered programs). Component cost analysis agencies that are not part of the development or acquisition chain are tasked to complete the statutorily required independent LCCE for **remaining ACAT IC** programs. The regulation also requires that the Program Office prepare a LCCE (known as the ***Program Office Estimate*** **(POE)**) in support of program initiation. The POE is to be updated for each subsequent milestone and decision review. For ACAT ID programs with significant cost risk or high visibility, the Component Acquisition Executive (CAE) may request a ***Component Cost Analysis*** **(CCA)** estimate be prepared in addition to the POE and the CAIG ICE.

  - For **ACAT IA** programs, neither law nor regulation prescribes an ICE, however the DoD 5000 series does require the cognizant OSD Principal Staff Assistant or sponsoring DoD Component to ensure that a CCA is created for Milestone B and each time the MDA requests an Economic Analysis (Milestones I and II, respectively for grandfathered

programs). The regulation also requires that the Program Office prepare a POE in support of program initiation and all subsequent milestone and decision reviews. Unlike an ACAT I POE, the ACAT IA POE must include life-cycle *benefits* as well as life-cycle costs. The cost/benefit element structure must be agreed to by the program's IPT.

OSD Cost Analysis Improvement Group (CAIG)

The OSD CAIG acts as the principal advisory body to the OIPT (Overarching Integrated Product Team), the ***Defense Acquisition Board (DAB)*** and the Secretary of Defense on matters relating to cost. The Deputy Director for Resource Analysis, Program Analysis & Evaluation (DD/PA&E(RA)) is dual-hatted as the CAIG chair. The CAIG membership consists of the CAIG Chair; one member appointed by each permanent DAB member; and ad hoc representatives as appointed by the CAIG Chair. Members of the CAIG represent their functional areas. Per DoD Directive 5000.4, the OSD CAIG has the following functions:

(1) Provide feedback to the component based on its independent review of the LCCE(s), validate the methodology used to make the estimate(s); and determine whether additional analysis is required.

(2) Provide the DAB with a review and evaluation of the POE and the CCA, if one is prepared.

(3) Provide the DAB with an independent analysis of cost implications of significant DAB issues (e.g., co-production in multinational programs, competitive alternative sources, alternative acquisition strategies, etc.).

(4) Provide a recommendation as to the reasonableness of the new Program Acquisition Unit Cost and Current Procurement Unit Cost for the Secretary of Defense certification to Congress for programs breaching established thresholds.

(5) Establish guidance on preparing cost estimates and detailed procedural guidance on CAIG presentations.

(6) Maintain an integrated cost analysis research program.

(7) Establish standard definitions of cost terms for DoD acquisition programs.

(8) Establish guidance pertaining to the Contractor Cost Data Reporting (CCDR) system and monitoring its implementation.

(9) Establish policy for and administer the Visibility and Management of Operating and Support Costs (VAMOSC) program.

Component Cost Analysis Agencies

Some DoD Components have established their own agencies to serve as their lead organization for cost analysis and cost estimating actions and to act as liaison between the Component and the OSD CAIG. Program office personnel involved with conducting or reviewing POEs should be aware of their respective Component's agency and contact that organization as appropriate on cost related issues. **Figure 2** provides information about how to contact each of these Component agencies as well as the OSD CAIG.

Component	Organization	Phone	Web Site
Army	Cost and Economic Analysis Center (CEAC)	(703) 601-4200 DSN 329-4200	www.ceac.army.mil
Air Force	Air Force Cost Analysis Agency (AFCAA)	(703) 604-0387 DSN 664-0387	www.saffm.hq.af.mil *(select AFCAA tab)*
Navy	Naval Center for Cost Analysis (NCCA)	(202) 764-2492 DSN 764-2492	www.ncca.navy.mil
OSD	Cost Analysis Improvement Group (CAIG)	(703) 695-0721 DSN 225-0721	www.pae.osd.mil

Figure 2

The Cost Review Process

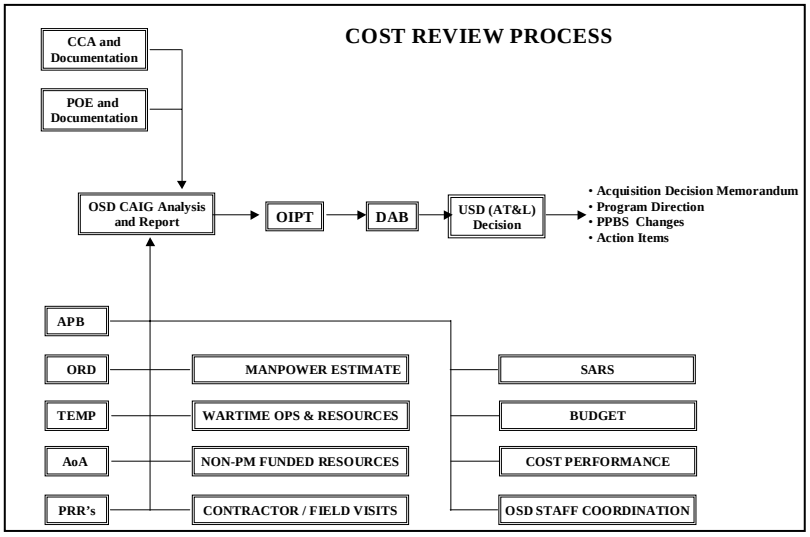

Figure 3

Figure 3 displays the cost review process for obtaining a Secretary of Defense program decision for a major weapon system. Each service prepares for the OSD CAIG meeting differently. In each service, the program team prepares the POE with in-house or contractor

personnel. However, non-government personnel are not allowed at the CAIG meeting. The CCA, if required, is prepared by the component's cost analysis agency, if one exists, or by some other office independent of the acquisition and development chain of command.

Army: The Army Cost and Economic Analysis Center (CEAC) prepares the CCA and briefs the results to the CAIG. The Army Cost Review Board works with the Assistant Secretary of the Army (Financial Management & Comptroller) to develop the Army cost position briefed to the CAIG.

Navy: The Naval Center for Cost Analysis (NCCA) prepares and briefs the CCA to the CAIG. The Navy holds a reconciliation meeting prior to the formal CAIG meeting.

Air Force: The Air Force Cost Directorate, SAF/FMCC, prepares the AF cost position, after reconciliation between the System Program Office estimate and the AF Cost Analysis Agency's CCA.

The CAIG report takes into consideration all the factors and information shown in the bottom portion of Figure 3. There must be cost consistency among all documents.

SUMMARY

Life-cycle cost estimates are essential sources of information for the materiel acquisition process. They provide the cost information to support the acquisition milestone decision process as well as the development of acquisition program budget requests.

Life-cycle costs can be viewed from three different perspectives: funding appropriations, WBS and life-cycle cost categories. Funding appropriations refer to the major categories of appropriations with which Congress provides DoD budget authority: RDT&E, Procurement, MILCON, MILPERS, and O&M. The WBS breaks down costs into hardware-related categories and helps ensure that no costs are overlooked. The life-cycle cost categories (R&D, Investment, O&S, and Disposal) are designed primarily for the use of DoD decision-makers.

At each milestone beginning with program initiation, as many as three life-cycle cost estimates (the POE, the ICE and the CCA) may be prepared to support the acquisition decision process for a new system. Except when specific estimates are required by law, the program's milestone decision authority decides which estimates will be prepared to support each milestone and decision review.